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Bismarck, North Dakota

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Big Bluestem Biomass Trials **in North Dakota, South Dakota,** **and Minnesota**



Helping People Help the Land

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Plants are an important tool for conservation. The Bismarck Plant Materials Center (PMC) is part of the United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). It is one of a network of 27 centers nationwide dedicated to providing vegetative solutions to conservation problems. The Plant Materials program has been providing conservation plant materials and technology since 1934.

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Acknowledgements

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*In this photo:
Big bluestem
seed that has been
debearded is smooth
and flows easily
through a grass drill.*

Big Bluestem Biomass Trials in North Dakota, South Dakota, and Minnesota

*Dwight Tober, Plant Materials Specialist; Nancy Jensen, Agronomist;
Wayne Duckwitz, Plant Materials Center Manager;
and Mike Knudson, Assistant Plant Materials Center Manager;
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Big bluestem (*Andropogon gerardii* Vitman) is a tall, warm-season perennial grass with short rhizomes. The species occurs naturally in every State in the continental United States except Washington, Idaho, Oregon, Nevada, and California. It also occurs in adjoining provinces of Canada (USDA NRCS 2006b). It is a very palatable grass to livestock. Crude protein and digestibility are high during the summer growing season. Seed production is good. Clean seed yields have averaged 100-200 pounds per acre at the USDA-NRCS Plant Materials Center (PMC) at Bismarck, North Dakota. Big bluestem prefers moist, well drained, deep soils but will tolerate dry, low pH, and low fertility soils. It is used for erosion control, livestock grazing, wildlife habitat, and native prairie restoration.

Dry matter biomass yields and other information were compiled from 1982 to 1992 at six sites in North Dakota, South Dakota, and Minnesota. The effects of seed origin (parentage) on plant performance was apparent. Seven seed sources/varieties of big bluestem were evaluated. Southern seed sources generally had heavier biomass production. Plant density (stand index) was generally greater for northern origin seed sources. Northern seed sources moved more than 200 miles southward from their origin generally performed poorly, and biomass was significantly less than more southern origin sources. There were less days to seed maturity (phenology) for the more northern origin seed sources compared to the more southern origin seed sources.

Trial Sites

The trial sites were studied in cooperation with numerous partners (see Acknowledgements). They were located near Upham, North Dakota; Fergus Falls, Minnesota; Rochester, Minnesota; Lake Andes, South Dakota; Onida, South Dakota; and Fort Pierre, South Dakota. Soils and precipitation information is included with the tables. Growing seasons at the six locations varied from an average



of 110 days at Upham, North Dakota, to an average of 150 days at Rochester, Minnesota. Average annual precipitation ranged from 15 to 30 inches. Seven to nine different species of warm-season grasses were evaluated at each site. Each species included two or more varieties or seed sources. Big bluestem is the only species presented in this report.

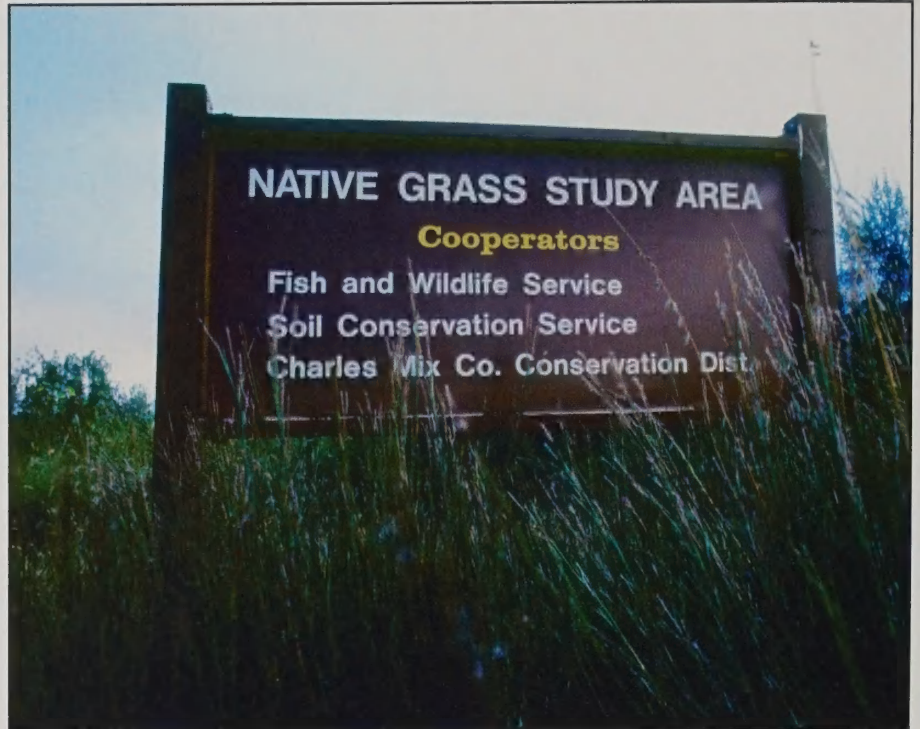
Methods and Materials

The experimental design was a randomized complete block with three replications for data collection.

An evaluation array was seeded for demonstration purposes. Plot size varied from 12 to 15 feet in width, and from 60

to 100 feet in length. A clean, firm seedbed was prepared by disking, harrowing, and roller packing. The plots were seeded using a native grass drill. Herbicides were used for weed control. Biomass residue was removed each spring either by mowing and raking, or burning. No fertilizer was applied.

Data collection at all six locations included stand ratings, plant height, weed contamination, stand index density, phenology, and annual biomass production. Only biomass production, stand density, and phenology are presented and discussed in this report.



All plots were planted into a clean, firm seedbed

Stand index density was determined by estimating the number of plants in a 9-inch by 16-inch quadrat. Ten quadrats were systematically counted near the center line of each plot. A density index rating was developed. Values ranging from 0 to 40 plants per square foot were used to estimate density for each subsample.

Oven-dried biomass production was documented at all sites beginning the second year following establishment. Biomass

production was determined by clipping a 2-foot by 10-foot subplot in each plot with a forage harvester. Sampling dates were as close as possible to the end of the growing season (first killing frost). The sample plots were systematically located within each plot across the treatment and clipped to a stubble height of approximately 2 inches. After weighing the large samples, small (100 gram) grab-samples were weighed, oven-dried at 60 degrees C for 48 hours, and reweighed to determine moisture content. Percent dry matter weight of the large sample was used to determine average annual biomass production in pounds per acre.



*Estimating plant density
in 10 quadrats/plot
to determine stand index*



*Sampling biomass harvest
to determine moisture content
and overall production*

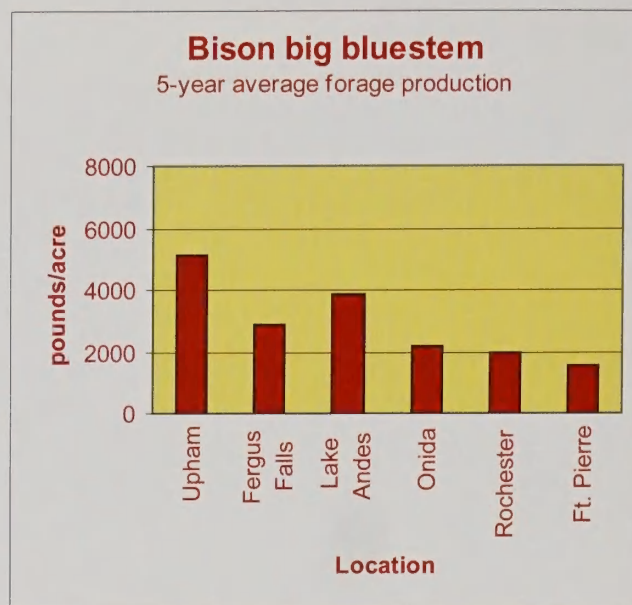


Harvesting 10-foot by 2-foot strips to determine biomass yield

Variety/Seed Source Origins

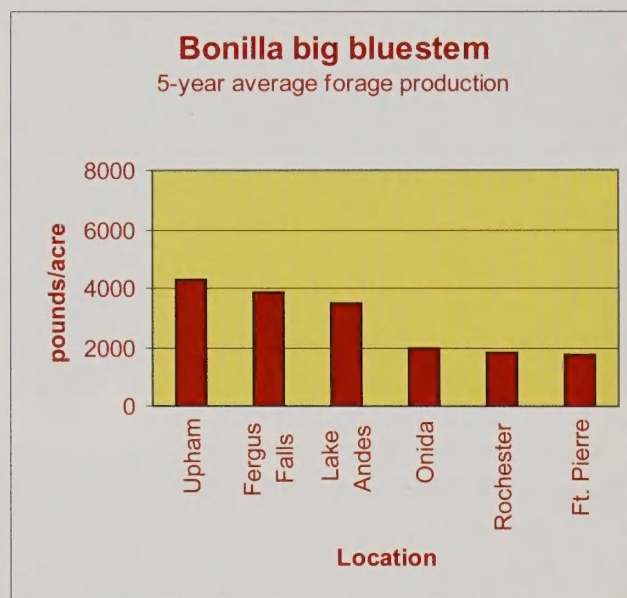
Bison

The original plants (NDG-4, PI 477994) were collected from a native stand near Price, Oliver County in central North Dakota. Plants were selected for uniformity of plant type, leafiness, vigor, seed yield, and winter hardiness. Bison is 20 days earlier in anthesis than Bonilla and 30-48 days earlier than Kaw, Champ, and Pawnee. It tends to be shorter in mature height. The chromosome number is $2n=6x=60$. Bison was released by the USDA-NRCS, Bismarck, North Dakota, and USDA-ARS and North Dakota and Minnesota Agricultural Experiment Stations.



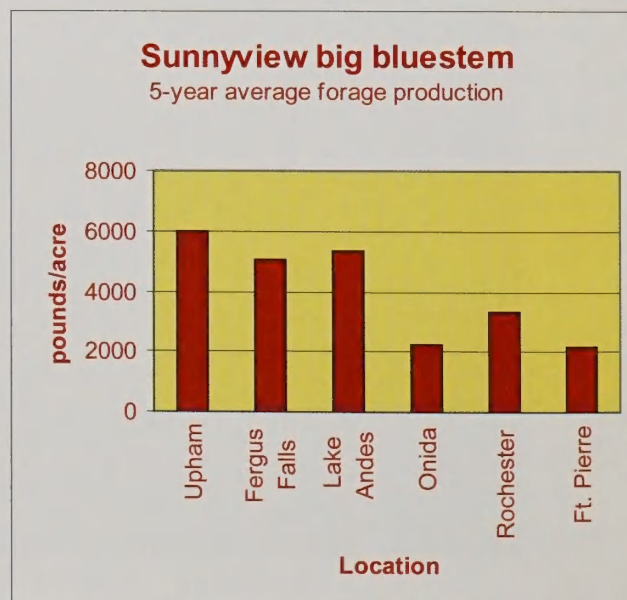
Bonilla

The original seed (SD-27, PI 315658) was collected from native stands at two sites near Bonilla, Beadle County in east central South Dakota. Plants grown from original seed collections were selected for high seed and forage yields, and winter survival. It was released by the USDA-NRCS, Bismarck, North Dakota, USDA-ARS, and the Agricultural Experiment Stations of North Dakota, South Dakota, and Minnesota.



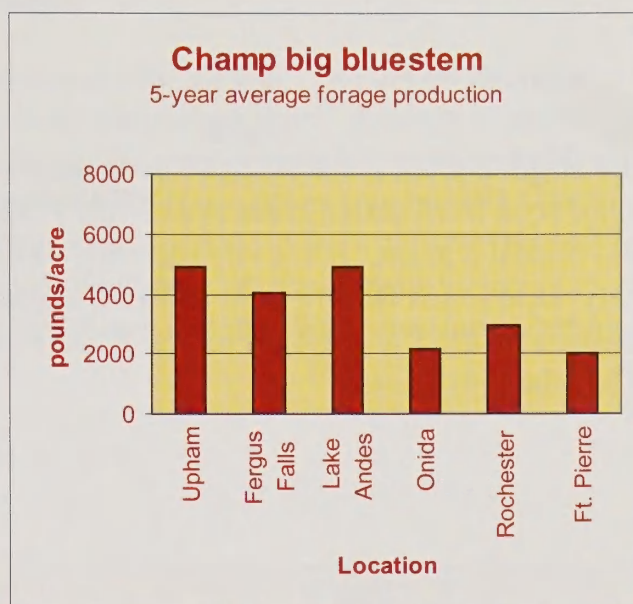
Sunnyview

The original seed (SD-43) was collected in Union County in southeastern South Dakota. Seed from two cycles of selection produced the breeder seed. Selections were made for increased seed viability, flower culm production, seed yield, vigor, and leafiness. It was developed and released by South Dakota State University in cooperation with the South Dakota Agricultural Experiment Station and USDA-NRCS, Bismarck, North Dakota.



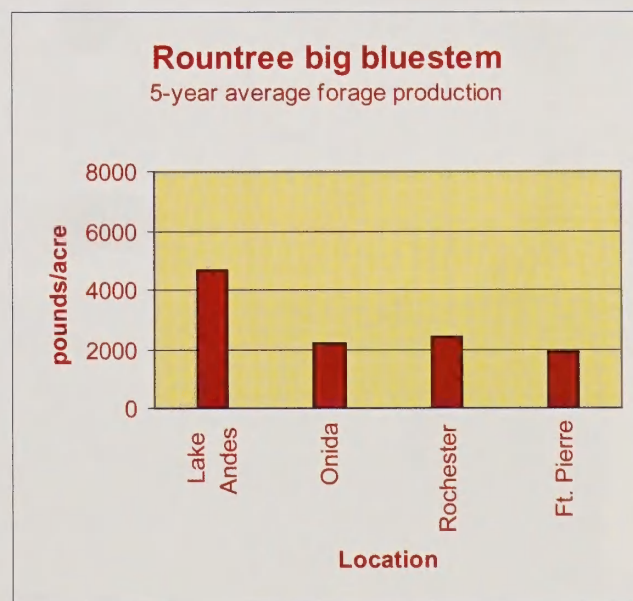
Champ

Champ was developed by hybridization of five typical clones of big bluestem (*Andropogon gerardii*) from the fine textured prairie soils of Iowa and southeastern Nebraska with five clones of sand bluestem (*Andropogon hallii*) from the northern Nebraska sandhills. It is leafy, and seed set and seed quality are superior to those of ordinary bluestem. It was developed and released by the USDA-ARS and University of Nebraska at Lincoln, Nebraska.



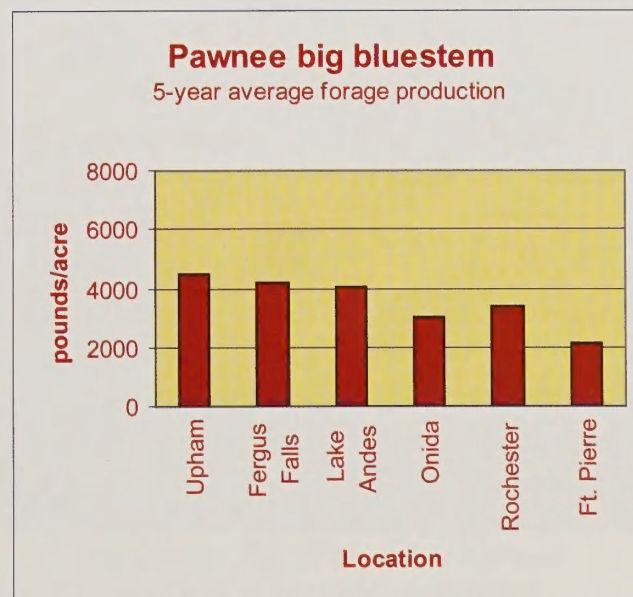
Rountree

Rountree originated from a native stand near Morehead, Monona County in west central Iowa. It was selected for increased seedling vigor, increased leaf rust resistance, superior forage and seed production, and increased resistance to lodging. It was developed by the USDA-NRCS at Elsberry, Missouri, in cooperation with the Missouri Agricultural Experiment Station.



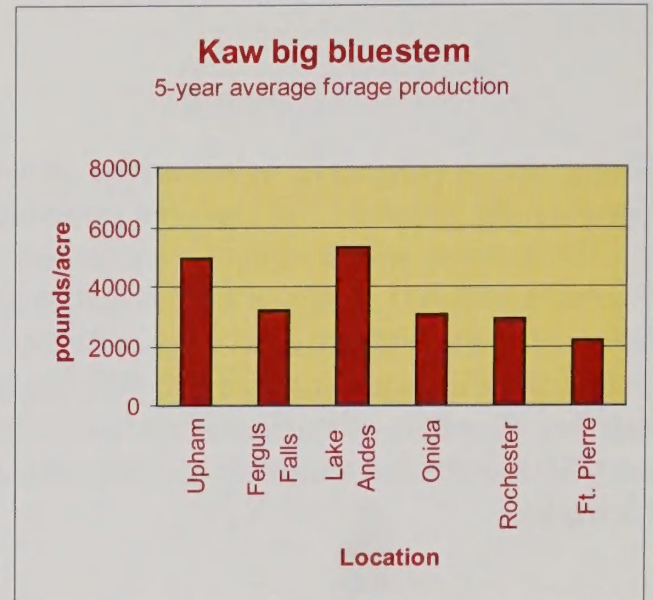
Pawnee

The original plant material was collected from native prairie in Pawnee County in southeastern Nebraska. Several generations of selections were based on culm height and inflorescence color. The amount of pubescence varies considerably on seed heads. Pawnee produces good forage yields superior to native strains. It was released by the USDA-ARS and the Nebraska Agricultural Experiment Station, Lincoln, Nebraska.



Kaw

The original plant material was a composite of collections from native grasslands in the Flint Hills of east central Kansas. It is a late maturing, tall, uniformly leafy variety that is somewhat resistant to rust. It was released by the Kansas Agricultural Experiment Station at Manhattan, Kansas.



Big bluestem provides high quality summer grazing

photo by Paul Nyren

Upham, North Dakota

Average annual precipitation for the five years of biomass harvest was near normal. The lowest biomass production was in 1987 when the average precipitation was 1.23 inches below normal. Average biomass yields were generally excellent on the fertile silty clay loam soils, and biomass generally averaged 4,000 to 6,000 pounds per acre, except in 1987. Sunnyview produced almost 8,000 pounds per acre in 1983. Bison and Bonilla, the two most northern origin varieties, had the highest average stand index estimate, 30 and 32, respectively. Kaw, the most southern origin variety, had the lowest density at 18. Plant maturity in early August varied from 50 percent ripe seed for Bison to vegetative for Kaw. Bonilla, Sunnyview, and Champ were at 50 percent anthesis.

Upham, North Dakota (MLRA 55A, north central North Dakota)

Average Annual Precipitation: 16.08 inches

Soils: Great Bend silty clay loam

Variety	(pounds/acre)							Stand	Phenology ³
	Biomass ¹							Index ²	
(inches)	1983	1984	1985	1986	1987	Avg	Rank	1982-1984*	Early Aug.
Precip. deviation	(0.98)	(0.9)	(1.63)	(-0.09)	(-1.23)				
Bison	6270ab	6181a	5298a	5335ab	2383bc	5093	2	30	7
Bonilla	6471ab	3444c	4486a	5121b	1796c	4264	6	32	5
Sunnyview	7981a	6361a	6269a	6862a	2469bc	5988	1	25	5
Champ	6719ab	4695b	4347a	5428ab	3403a	4918	3	21	5
Pawnee	5877ab	5075ab	4641a	4948b	1997bc	4508	5	26	3
Kaw	4601ab	5194ab	6189a	5842ab	2752ab	4916	4	18	1

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

²**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40

³**Phenology** (1984): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more;

5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy

* Data is an average from these years



Sunnyview had the highest 5-year average biomass yield (5,988 lb/ac)



Bison and Bonilla had the highest average stand index estimates

Fergus Falls, Minnesota

The soils on this site are a well drained loam complex formed in calcareous glacial till. There were two years of well below normal precipitation, 1983 (-3.96) and 1987 (-7.2). The lowest biomass yields overall were in 1987 when the average annual precipitation was more than 7 inches below average. Bison and Kaw had the lowest average biomass yields and the earliest and latest phenology, respectively. The other varieties had average biomass yields of 4,000 to 5,000 pounds per acre. Sunnyview again had the highest biomass yield across all years, with 6,623 pounds per acre in 1984. Bison and Bonilla had the highest stand index at 23 and 25, respectively. Phenology in early September varied from ripe seed for Bison and Bonilla to jointing for Kaw. Pawnee was at first emergence of inflorescence, and Sunnyview and Champ were at 50 percent anthesis.

Fergus Falls, Minnesota (MLRA 102A, west central Minnesota)

Average Annual Precipitation: 23.52 inches

Soils: Barnes and Langhei loam

Variety	(pounds/acre)							Stand	Phenology ³
	Biomass ¹							Index ²	
(inches)	1983	1984	1985	1986	1987	Avg	Rank	1983-1984*	Early Sept.
Precip. deviation	(-3.96)	(1.54)	(.85)	(6.23)	(-7.2)				
Bison	4139a	3283b	2615a	3053b	1298b	2878	6	23	7
Bonilla	5058a	4370ab	3981a	3883ab	2055ab	3869	4	25	6
Sunnyview	4613a	6623a	3908a	6528a	3439a	5022	1	20	5
Champ	3875a	4813ab	4664a	4664ab	2129ab	4029	3	14	5
Pawnee	5295a	5591ab	4059a	3948ab	2141ab	4207	2	21	3
Kaw	4673a	3892ab	3108a	2760b	1629ab	3212	5	21	2

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

²**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40

³**Phenology** (1983): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy

* Data is an average from these years



*Phenology was recorded
throughout the growing season*



*Sunnyview had the highest
5-year average biomass yield (5,022 lb/ac)*

Lake Andes, South Dakota

The soils are a fertile Agar silt loam. Three years of above average rainfall influenced biomass production at this site. The highest biomass yields were recorded in 1986 when all entries averaged between 5,338 and 7,809 pounds per acre. Sunnyview had the highest annual yield in 1986 and the highest five-year average biomass yield. Bonilla had the highest stand index at 39, and Champ the lowest at 15. Phenology in early September varied from Bison and Bonilla having first ripe seed, to Pawnee and Kaw, being at first anthesis. Sunnyview, Champ, and Rountree were at 50 percent anthesis.

Lake Andes, South Dakota (MLRA 55C, southeast South Dakota)

Average Annual Precipitation: 21.37 inches

Soils: Agar silt loam

Variety	(pounds/acre)							Stand	Phenology ³
	Biomass ¹							Index ²	
(inches)	1984	1985	1986	1987	1988	Avg	Rank	1984	Early Sept.
Precip. deviation	(12.9)	(-.21)	(10.7)	(3.71)	(1.0)				
Bison	2272c	4907a	5338a	2937bc	3725c	3836	6	27	6
Bonilla	4086abc	2441a	5536a	2125c	3195c	3477	7	39	6
Sunnyview	4887ab	4262a	7809a	4200ab	5427ab	5317	1	24	5
Champ	4114abc	4164a	5377a	5095a	5745a	4899	3	15	5
Rountree	3426bc	3663a	7657a	4502a	4168bc	4683	4	16	5
Pawnee	3658abc	4084a	5928a	2810bc	3885c	4073	5	29	4
Kaw	5629a	3846a	7796a	4505a	4591abc	5273	2	29	4

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

²**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40

³**Phenology** (1984): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy



One of many evaluation site tours



Plots of big bluestem were randomized with plots of six other warm-season species

Onida, South Dakota

The soil at the site is a Lowry silt loam, which is fertile but droughty. Average annual precipitation was near normal for three years, considerably above normal in 1986 (5.27 inches), and below normal in 1988 (-4.07 inches). The two most southern origin sources, Kaw and Pawnee, had the highest five-year average biomass production with over 3,000 pounds per acre. Both entries yielded over 7,000 pounds per acre with high rainfall in 1986. The remaining five varieties each had a similar five-year average biomass production of approximately 2,000 pounds per acre. Sunnyview was ranked second for five-year average biomass production and produced almost 6,000 pounds per acre in 1986. Stand index ratings were similar for all entries and ranged from 21 to 31. Phenology differences were similar to the other sites. Bison, the earliest maturing, had ripe seed while Pawnee and Kaw, the latest maturing, were at first anthesis in early September. Bonilla, Sunnyview, Champ, and Rountree were at 50 percent anthesis or first seed ripe.

Onida, South Dakota (MLRA 53C, central South Dakota)

Average Annual Precipitation: 17.47 inches

Soils: Lowry silt loam

Variety	(pounds/acre)							Stand	
	Biomass ¹							Index ²	Phenology ³
(inches)	1985	1986	1987	1988	1989	Avg	Rank	1984-1985*	Early Sept.
Precip. deviation	(.13)	(5.27)	(-1.86)	(-4.07)	(.33)				
Bison	405c	4588a	3120a	1571a	1237a	2184	3	28	8
Bonilla	666bc	4625a	3208a	856a	392a	1949	6	26	6
Sunnyview	889bc	5913a	2768a	1006a	699a	2255	2	26	6
Champ	1148abc	5222a	2611a	826a	862a	2134	5	25	5
Rountree	1167abc	4897a	2376a	905a	1398a	2149	4	21	5
Pawnee	1545ab	7271a	3115a	1657a	1556a	3029	1	31	4
Kaw	1988a	7597a	3571a	1448a	540a	3029	1	25	4

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

²**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40

³**Phenology** (1986): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy

* Data is an average from these years



Rochester, Minnesota

The soils are a well drained, rolling silt loam. This site, with 29.58 inches, had the highest annual precipitation of the six test sites. Precipitation was quite variable from year to year. Precipitation was below normal in 1987 (-2.63), 1988 (-8.19), and 1989 (-6.85). It was substantially above normal in 1990 (14.36), and 1991 (7.33). Biomass was significantly less than expected on this site for all entries. The droughty soils with low fertility may have been a factor. Sunnyview had the highest biomass yield in 1987 at 5,879 pounds per acre, and the second highest five-year average biomass at 3,346 pounds per acre. Pawnee had the highest five-year average biomass at 3,377 pounds per acre. Bison and Bonilla had the lowest five-year average biomass yields at 1,944 pounds per acre and 1,803 pounds per acre, respectively. Sunnyview and Kaw had the lowest stand index estimates at 10 and 18, respectively. The highest stand index estimates were for Champ and Rountree, both at 25. Bison had the earliest phenology, with mature seed in early September while Bonilla was at 50 percent ripe seed, and Kaw was at first anthesis.

Rochester, Minnesota (MLRA 105, southeast Minnesota)

Average Annual Precipitation: 29.58 inches

Soils: Mount Carrol silt loam

Variety	(pounds/acre)							Stand	Phenology ³
	Biomass ¹							Index ²	
(inches)	1987	1988	1989	1990	1991	Avg	Rank	1985-1987*	Early Sept.
Precip. deviation	(-2.63)	(-8.19)	(-6.85)	(14.36)	(7.33)				
Bison	2182 _c	2595 _a	1917 _b	1769 _b	1255 _a	1944	6	23	8
Bonilla	3164 _{bc}	1899 _a	2012 _b	1477 _b	461 _c	1803	7	21	7
Sunnyview	5879 _a	2816 _a	3947 _a	2244 _{ab}	1844 _{ab}	3346	2	10	6
Champ	5543 _a	2430 _a	2091 _b	3495 _a	1313 _{ab}	2974	3	25	6
Rountree	4354 _{ab}	1330 _a	2417 _{ab}	2599 _{ab}	1204 _{bc}	2381	5	25	6
Pawnee	5508 _a	2908 _a	3452 _{ab}	2971 _{ab}	2048 _a	3377	1	22	5
Kaw	4982 _{ab}	2779 _a	2489 _{ab}	2611 _{ab}	1575 _{ab}	2887	4	18	4

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

²**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40

³**Phenology** (1988, 1989): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy

* Data is an average from these years



Fort Pierre, South Dakota

The soil at the site is Promise clay, which is fertile with low permeability. Infiltration is less than 0.2 inches per hour. Three consecutive years (1988, 1989, 1990) of significantly lower than normal rainfall greatly reduced annual and five-year average biomass yields. Average annual biomass yields were generally less than 1,000 pounds per acre. Precipitation was slightly above normal in 1991 and 1992, and biomass yield for some varieties was more than 4,000 pounds per acre. Champ, Pawnee, and Kaw each had approximate biomass yields of 5,000 pounds per acre in 1992. Sunnyview again had the lowest stand index density (10), and Pawnee (30) and Bison (28) had the highest. The phenology of each variety was similar to that at other sites. Bison and Bonilla had mature seed in early September and Kaw and Pawnee were vegetative or just starting to joint.

Fort Pierre, South Dakota (MLRA 63A, central South Dakota)

Average Annual Precipitation: 18.08 inches

Soils: Promise clay

Variety	(pounds/acre)							Stand	Phenology ³
	Biomass ¹							Index ²	
(inches)	1988	1989	1990	1991	1992	Avg	Rank	1986-1987*	Early Sept.
Precip. deviation	(-7.3)	(-4.77)	(-5.74)	(.87)	(.79)				
Bison	793a	87c	541b	4159a	2060c	1528	7	28	8
Bonilla	780a	93c	827ab	3680a	3259b	1728	6	23	8
Sunnyview	942a	322a	716b	4124a	4611a	2143	2	16	6
Champ	528a	152bc	827ab	3498a	5030a	2007	4	28	6
Rountree	788a	194b	690b	3419a	4296ab	1877	5	26	5
Pawnee	736a	235ab	1032ab	3640a	4964a	2121	3	30	2
Kaw	881a	297a	1305a	3481a	4968a	2186	1	22	1

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)

¹**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height

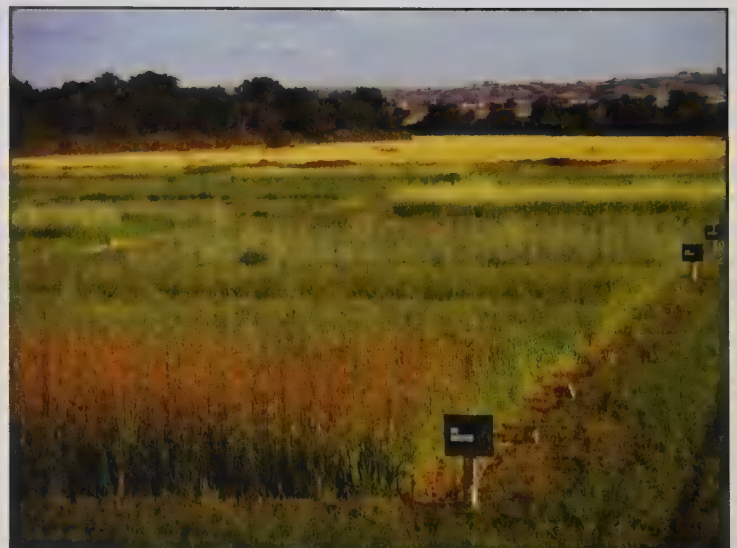
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³**Phenology** (1990): 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis, 10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy

* Data is an average from these years



*Biomass was harvested
at end of the growing season*



*Big bluestem was one of seven species
evaluated in replicated plots*

Results and Discussion

Biomass production at all six locations was heavily dependent on seasonal precipitation patterns. Seed origin was also critical in overall performance, especially plant phenology. Previous studies in the Northern Plains by the Bismarck PMC have generally shown that native warm-season grass species can be moved about 300 miles north or 200 miles south of their original collection location. East and west movement is affected by moisture and elevation (USDA NRCS 2006a). Bison and/or Bonilla ranked towards the bottom, except at Upham, for five-year average biomass production. These were the northern-most varieties in the trial and originated from central North Dakota and east-central South Dakota, respectively. Varieties producing the most biomass at each site varied across the plot locations. Generally, the more southern origin varieties produced the most biomass. Sunnyview consistently produced high biomass yields. It was the top five-year biomass producer at Upham, Fergus Falls, and Lake Andes; and was second at Rochester and Fort Pierre.



*Days to ripe seed after July 15
varied from approximately
60 days (Bison) to 115 days (Kaw)*

Stand index densities were rated at all six sites. Generally, the more northern seed sources, Bison and Bonilla, had the greatest stand densities. The stand densities of the other varieties were inconsistent across the six sites. The effects of soil differences were not apparent.

Phenology was variable across sites with annual precipitation and temperatures affecting plant maturity. Varieties having the earliest and latest maturities were similar at all six sites. Bison had the earliest maturity and Bonilla had the next earliest seed maturity at all sites. Both varieties generally had mature seed in early September. The remaining varieties varied somewhat in seed maturity across sites except for Kaw, originating from east central Kansas, which had the latest maturity at all sites.

Variety Recommendations for North Dakota, South Dakota, and Minnesota

Variety	Origin	Days to Ripe Seed after July 15	Where Adapted
Bison	central North Dakota	60	ND, SD, MN
Bonilla	east central South Dakota	80	ND, SD, MN
Sunnyview	southeast South Dakota	90	ND, SD, MN
Champ	Iowa, Nebraska	95	SD, southern MN
Rountree	west central Iowa	100	SD, southern MN
Pawnee	central Nebraska	105	SD, southern MN
Kaw	east central Kansas	115	not recommended in ND, SD, MN

Key Establishment and Management Considerations

- **Soils/Adaptation:** Plant performance is best on moist, well drained, moderate to fine textured deep soils in areas of greater than 14 inches of average annual precipitation. Western and northern varieties are generally adapted to drier conditions. It is not very tolerant of heavy clays, extremely wet bottomlands, deep sands, high salinity, or high lime (USDA NRCS 2006b).
- **Seeding:** Big bluestem seed is relatively small, with approximately 176,000 seeds per pound. The seed has hairy appendages (awns). Using debearded (awns removed) seed greatly improves seed flow through a seed drill. The extent of debearding varies greatly among seed lots. If seed is not debearded, it should be planted through the chaffy seed box found on grass drills. The NRCS recommended drilled seeding rate for North Dakota is 7.5 pounds (approximately 30 seeds/sq ft) in the east and 6 pounds (approximately 25 seeds/sq ft) in the west (Sedivec et al 2001). Rates are calculated on Pure Live Seed (PLS). Broadcast seeding rate is higher than the recommended drill rates. Seeding rates vary across the United States, generally increasing from west to east. Spring seeding is recommended. A firm seedbed is essential for a shallow seeding depth ($\frac{1}{4}$ - $\frac{1}{2}$ inch). Studies have shown an average germination of 61 percent when planted $\frac{1}{2}$ inch deep and zero germination when planted $1\frac{1}{2}$ inches deep (USDA NRCS 2003).



*Big bluestem seed
with awns*



*Big bluestem seed
with awns removed (debearded)*

- **Weed Control:** Abundant broadleaf weeds and annual grasses need to be controlled by mowing or herbicide application. Dense stands of foxtail (*Setaria* species) can be very competitive and significantly reduce stand establishment. Herbicides are generally more effective than mowing in controlling annual grasses.
- **Fertilization:** Biomass quality and yield, and seed production can be improved with nitrogen application. A soil test is recommended to achieve maximum productivity.
- **Grazing/Haying/Mowing:** Big bluestem is a high quality forage species for all classes of livestock. Big bluestem can withstand substantial grazing, but close grazing can decrease the stand. It is highly palatable to livestock in the spring and summer and becomes coarse and less palatable during the fall and winter. For high quality forage, start grazing at a height of 8-14 inches and graze to a 6-inch stubble height. Stocking density should be high enough to use most of the grass before the seed stalks develop. Rotational grazing is recommended to reduce trampling and enhance utilization.

Hay should be mowed in early to mid-summer to maintain high nutritional quality. Crude protein averaged 14 percent in late June in trials in southwestern North Dakota. Crude protein dropped to 10 percent in mid-July, 8 percent in early August, and less than 6 percent in mid-September (Craig et al 2001). For hay production, cut big bluestem at boot stage, leaving a 6-inch stubble. Forage yields may be greater when grazing or haying at heading, but forage quality will be lower.

- **Burning:** Big bluestem benefits from burning of plant residue prior to initiation of spring growth. Advantages include low impact residue removal, weed control, more uniform growth initiation and seed ripening, improved nutrient cycling, and more vigorous growth. Burning annually at the Bismarck PMC has increased long-term seed yields.
- **Seed Harvest:** Seed shattering can occur shortly after the first seed is ripe. Strong winds or pounding rains can quickly shatter ripe seed. Seed can be harvested using a conventional combine or a specialized seed stripper. Seed is subject to heating, so should be dry before storing in a bin or other containers.



A prescribed burn is an important management tool

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Fall color of big bluestem



Big bluestem in full flower (anthesis)



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